mesytec **MSI-8** is a compact 8 channel preamplifier shaper box with integrated timing filter amplifiers. Due to the modular setup, preamplifier and shaper module types can be selected individually for each channel. MSI-8 is the ideal solution for setups with a mix of different detectors requiring individual bias supply and energy ranges. It is also well suited for moderately segmented strip detectors or as an easy to use and flexible lab system.

Features:

- Gain continuously adjustable by a factor of 50 (front adjustment factor 10, Jumper at preamp x5)
- 8 channel compact standalone module
- Preamplifier and shaper modules individually selectable
- Shaper with baseline restorer
- Two shaping times, jumper selectable
- Integrated timing filter amplifier
- Individual and common timing output
- Single and common detector bias
- All outputs can be terminated with 50 Ω
- Lemo connectors for in- and outputs
- Discriminator gate output for peak sensing ADC
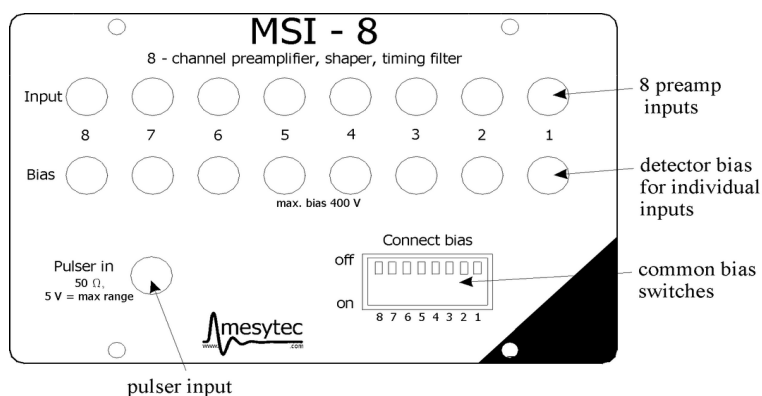
Schematics:
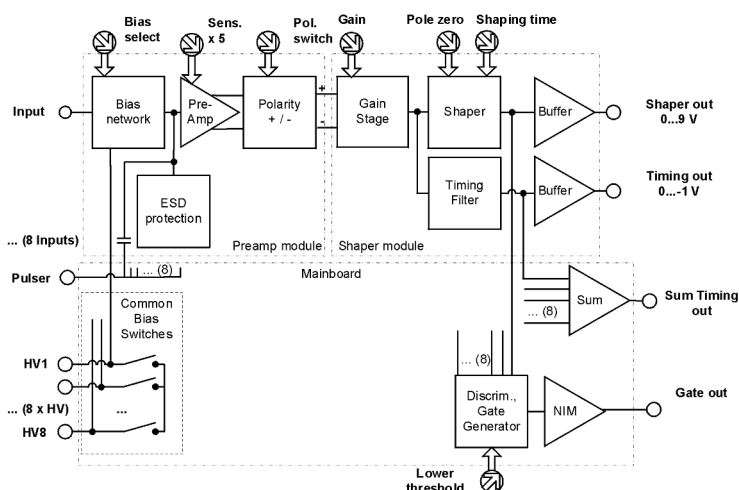
System Design

MSI-8 has a very flexible modular design. Preamplifiers and shaper, timing filter amplifiers are pcb modules mounted on a common main board. They can be chosen individually for each channel. This gives maximum flexibility for multi channel setups with different detectors.

Rear Panel

pulser input
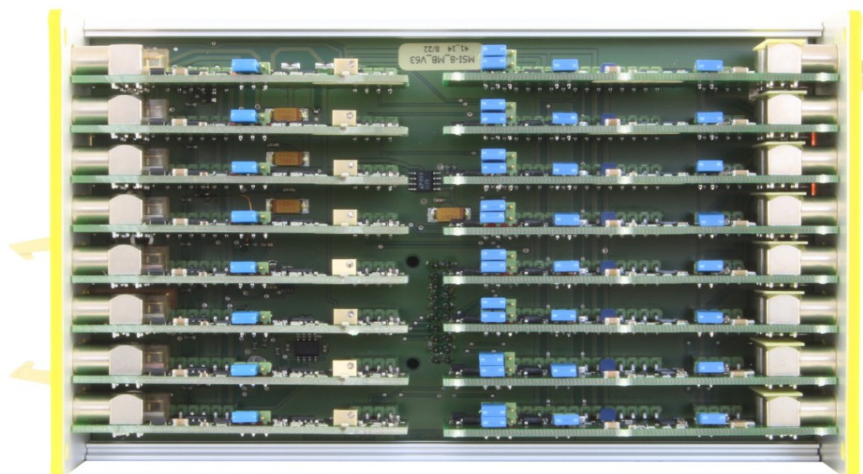
Preamplifier inputs

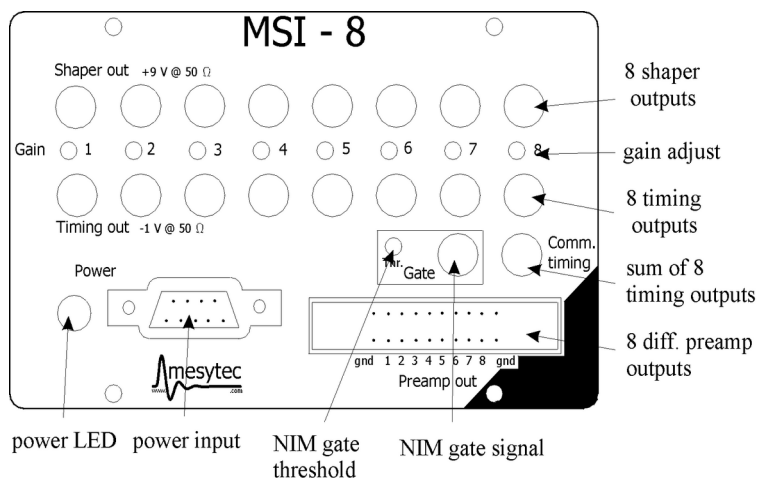• Lemo connectors directly situated on the preamplifier module

Detector bias

• Lemo connectors directly situated on the preamplifier module
• Connect bias switches allow to select a channel group to be commonly biased. (Bias inputs of this group are connected). This allow easier cabling.

Pulser input

• Tail pulse, or square pulse
• Internally terminated with 50 Ω
• Typically 5 V for maximum output voltage at minimum gain

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Front Panel

power LED   power input   NIM gate threshold   NIM gate signal

Shaper outputs

- Lemo connector
- Positive, Gaussian pulse
- Max 10 V (8 V at 50 Ω)
- Two jumper selectable shaping times (standard is 1 us FWHM and 2 us FWHM equals to 0.5 us and 1 us shaping time)
- Gain adjustable by a factor of 10 via front panel trim potentiometer.

Timing output

- Lemo connectors
- Fast negative signal
- Max –1 V
- scales with shaper gain setting

Common timing output

is a sum of all individual timing outputs.

Differential preamp outputs

- 20 pin standard connector
- 8 differential preamp signals
- Can be connected to a twisted pair cable and terminated with 100 Ω
- Amplitude: ±1 V for maximum range

Gate output and gate threshold adjust

- NIM signal output
- Useful for gating an external peak sensing ADC in lab tests. As long as one of the shaper outputs exceeds the threshold voltage, the NIM-output gets negative.

Power supply

- SUB-D 9 female connector. (NIM convention)
- Supply voltages (currents for box with 8 shapers and 8 preamps)

  +12 V   250 mA
  +6 V   50 mA
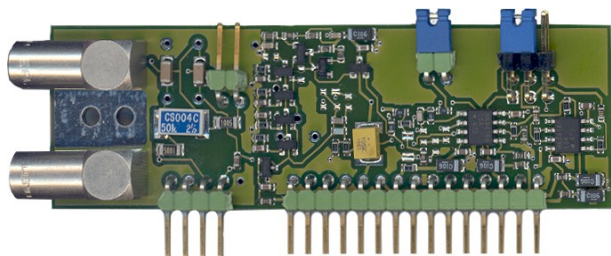 –6 V   –170 mA
  total power: 4.3 W

- Pin connections (numbers are noted on the connector):

pin	name	pin	name
1	Gnd	6	Not connected
2	Gnd	7	Not connected
3	+6 V	8	Not connected
4	+12 V	9	Not connected
5	–6 V		

Box size

length = 170 mm
width   = 105 mm
height =   67 mm

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Preamp Module (MMPR-1)

Input

- The standard preamplifiers can handle a detector capacity of up to 1000 pF

Detector bias

- Maximum bias voltage: ±400 V
- Bias filter 10 MΩ / 50 MΩ
  (selectable by internal jumper)

Sensitivity

Attenuator switch by factor of 5

Polarity

a double swich allows to select the input polarity. The two jumpers always have to be side by side. Left position negative input charge, right position positive input charge.
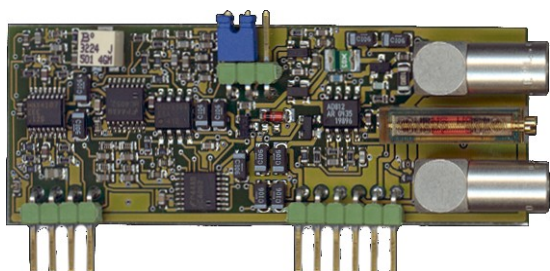
Power consumption

- Low power: typ 150 mW
- cooling not necessary

For details see data sheet of MMPR-1

Shaper Module (MMSH-1)

The module includes a shaper with passive baseline restorer, an output driver for 10 V (8 V @ 50 Ω) and a timing filter stage with timing output. **The jumper allows to select one of the two shaping times.**

Shaper Output

- Gain potentiometer factor of 10
- Filtering: quasi Gaussian $(CR(RC)^5)$
- Shaping (FWHM):
  - 2 us FWHM =1us sht: jumper pos left
  - 1 us FWHM =0.5us sht: jumper pos right

- Baseline shift with frequency:
  - A passive baseline restorer is integrated
  - For 1 us (FWHM) shaping time and a rate of 100 kHz, the baseline shifts less than 100 mV (1 %)
  - DC Offset at shaper output: ΔU <10 mV

Pole zero adjust:

- Modules are adjusted to less than 20 mV of undershoot at the shaper output
- **You can readjust if necessary**

Timing Output

- Timing filter amplifier
  (is included on the shaper module)
  - integration: 7 ns
  - differentiation: 200 ns
- Noise:
  $N = (70 + C_{Det}) * 0.35$
  C_{Det} = cable + detector capacity, in pF;
  N = noise FWHM in keV;

Power consumption

+12 V   10 mA
–6 V   10 mA
total power = 180 mW

Connector

(left pin = 1)

pin	name	pin	name
1	gnd	6	+12 V
2	in+	7	gnd
3	in–	8	out shaper
4	gnd	9	out timing
5	–6 V	10	gnd

For details see data sheet MMSH-1

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Timing considerations

Best timing

- Use high bias voltage to get maximum charge carrier velocity in the intrinsic zone of the detectors
- Implant particles with low range on the p-side (=strip side or guard ring side for 2 sided detectors)!

Time resolution

(MCFD-16 discriminator processing the TF-signals in leading edge mode was used for measurements)

- Use a low threshold to minimize walk
- If you have a wide range of input amplitudes, use shaped signals for walk-correction
- If the signal is much larger than the noise, the timing resolution Δt can be estimated:

$$\Delta t = 20ns * \left(\frac{N}{S} \right)$$

N = noise [MeV]
S= signal amplitude [MeV]

- For 100 pF detector + cable capacity and 1 MeV signal this means a timing resolution of Δt = 1 ns
- Timing resolutions better than 100 ps are difficult, even for large signals

With external constant fraction discriminator

- fraction = 0.25, delay = 15 ns
- timing is 25 % worse, but walk correction is intrinsic

Common timing output

- For low energies (<10 MeV) about three times worse than single channel timing (noise increased by √8)

- For higher energies
  Noise is not the limiting factor. If a coincidence with responding energy channels is used in software, the 8 channels can be calibrated with individual timing offset parameters.
  If there is no coincidence, the timing information will not get better than 0.5 ns due to delay tolerances for the 8 channels.

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